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Observations on Feeding Habits of First-instar Larvae of the Pale Western Cutworm, *Agrotis orthogonia* Morr. (Lepidoptera: Phalaenidae)[1]

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The pale western cutworm, *Agrotis orthogonia* Morr., has been a major pest of cereals in the prairie region of Western Canada since 1911. Present control measures consist of (a) cultural measures that inhibit oviposition in fields being summer-fallowed and (b) starvation of the young larvae by destroying the volunteer plant growth by means of cultivation at a critical period. Cultural operations to minimize oviposition in fields being summer-fallowed have become accepted procedure throughout the area. Control by starvation is practised during outbreak years in fields that have been "stubbled in" or in those tilled during the moth flight. This procedure has been recommended generally throughout potentially infested areas, but more precise methods of evaluating larval numbers are required so that control may be used only where critical populations are present.

Experiments on the feeding behaviour of first-instar larvae were commenced for a twofold purpose: first, to investigate the feasibility of estimating larval numbers in the field by observing the feeding on vegetation; and, second, to obtain information on feeding habits that might lead to satisfactory control by the use of chemicals.

Experimental Methods

Wheat was grown in the greenhouse in one-gallon, glazed earthenware crocks, seven inches in diameter and filled to within one and one-half inches of the top with sandy clay loam. Newly hatched larvae were placed on the soil surface in the centre of each crock as the wheat was emerging. When feeding commenced, each crock contained ten healthy plants seeded in a circle half-way between the centre and the edge of the crock.

The experiment involved five levels of larval population: 0, 5, 10, 20, and 40 larvae per crock. Each level was replicated five times.

Larval Feeding

Within one hour after the larvae were placed on the soil all had made their way below the surface. No larvae were observed climbing and feeding on the plants.

First damage to the growing wheat plants was noted within 24 hours. With the aid of back lighting, damage in the form of feeding holes in the plants was observed. Closer examination disclosed that the larvae had made holes through the coleoptyle to feed on the enclosed furled leaf, which is the elongating portion of the wheat plant. These feeding punctures were always below the soil surface, usually about one-eighth to one-quarter of an inch.

Damage showed up as regularly spaced holes, often paired, in the elongating first leaf shoot. Apparently the larva fed on the developing leaf through the hole in the fleshy coleoptyle. The appearance of unpaired or paired holes above

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the ground depended upon whether feeding took place on a single or on a double layer of leaf.

The holes in the growing leaf were at intervals of two to three millimetres; occasional gaps between holes indicated temporary cessation of feeding by the larva. During the pre-moult stage, when no feeding occurs, no holes were found in appropriate portions of the leaves.

Figs. 1 and 2 show the type of damage observed. The feeding holes in the inner, elongating leaf are plainly visible. In Fig. 1 the holes appear at varying intervals in a single row, whereas in Fig. 2 the holes are paired, indicating that the larva fed through two layers of the furled leaf. With the aid of back lighting in Fig. 1 the holes are visible through the portion of the coleoptyle just above the soil surface. The coleoptyle is punctured not above the ground but below the soil surface at the level where the larva is feeding.

Earlier workers on the pale western cutworm have described the feeding of first-instar larvae in the field. Cook (1), working in Montana, made the following statement: "The larvae feed above ground, on tender sprouts of wheat, for the first two weeks or so, when this feeding is indicated by small irregular areas cut from leaves. Soon they go underground to feed . . ."

Fig. 1

Single feeding holes caused by first-instar larvae of the pale western cutworm in the growing leaf of wheat, and appearance of plant near the soil surface.

Giving a photograph of feeding holes in leaves, with an indication of the paired notching effect, Webster and Ainslie (3) said: "The injury caused by the newly hatched cutworm is light, consisting of tiny holes eaten through the blades of the growing plants. Not until the cutworms were much larger were they able to cut off whole plants."

A similar statement was made by Seamans (2): "The first stage cutworms are very small and they feed almost entirely above ground. They are seldom noticed and their activities consist of cutting notches and holes in the leaves of the young plants . . .

"After the larvae start feeding below ground, the plants are usually cut off and a small portion of the underground stem is eaten."

It appears that previous workers had observed the typical symptoms of feeding of first-instar larvae on wheat leaves and had deduced that the holes could be made only by the larvae feeding above ground on the exposed plant surface.

Continuous observations were made on the plants grown in the greenhouse and in the laboratory, at all times of the day and night and in light and darkness, and at no time were larvae observed feeding on the surface. Apparently, first-instar larvae feed entirely below ground; the feeding holes on the growing plant

Fig. 2

Paired feeding holes caused by first-instar larvae of the pale western cutworm in the growing leaf of wheat, and appearance of plant near the soil surface.

are made below the soil and as the leaf elongates the damage becomes visible.

It was found that a single larva was responsible for a series of feeding holes and notches on the growing leaves. When two larvae fed through the coleoptyle from two different points, the number of holes visible above the surface was increased. Individual larvae continued feeding on a single plant and remained in close association with it throughout the first instar. Only when several larvae fed on the same plant and destroyed it did they move to another plant. On several occasions a head capsule was found on the furled portion of the leaf, about one inch above the soil surface, indicating that a moult had occurred in such close proximity to the stem that the moulted head capsule had been carried upward with the elongating leaf through the coleoptyle. A single instance was noted in which the entire larva was trapped in the growing leaf and had become enclosed within its tissues.

Plant Damage

Along with observations on feeding, counts were made of the number of plants damaged. Damage consisted of holes in the growing leaf and occasionally of complete plant loss when the leaf fell over after the shoot was notched through. Severance of plants, which is usually associated with cutworm feeding, was found only when the larvae had been extremely abundant or when they had been sufficiently large to be capable of cutting through almost all of the growing leaf.

The numbers of damaged plants in all replicates of each population are

TABLE I.

Numbers of Wheat Plants Damaged by Various Numbers of First-Instar Larvae of *Agrotis orthogonia* Morr.

Number of Larvae per Crock of 10 Plants	Number of Days	Number of Plants Damaged — Replicate 1	2	3	4	5	Total
	1	0	0	0	0	2	2
	2	2	4	1	1	4	12
5	3	4	4	1	2	4	15
	4	5	4	1	2	5	17
	5	6	4	1	2	5	18
	6	6	4	2	2	5	19
	7	7	5	2	2	5	21
	1	0	0	0	1	0	1
	2	3	2	1	5	4	15
	3	4	2	1	5	4	16
10	4	5	3	1	5	6	20
	5	5	4	5	7	6	27
	6	5	4	5	7	7	28
	7	5	4	5	8	8	30
	1	0	0	0	0	0	0
	2	6	6	4	5	6	27
	3	6	7	4	6	6	29
20	4	7	8	6	8	6	35
	5	8	8	6	8	7	37
	6	8	9	6	8	7	38
	7	8	9	9	8	10	44
	1	0	0	0	0	5	5
	2	8	6	7	3	10	34
	3	9	6	9	3	10	37
40	4	9	10	10	3	10	42
	5	9	10	10	3	10	42
	6	9	10	10	7	10	46
	7	10	10	10	9	10	49

shown, by days, in Table I; the data for the controls are not shown, as no damage was observed. The data indicate that the severity of plant damage increases with increased larval population. The ratio of larvae to damaged plants was not constant, as it was possible for several larvae to feed on the same plant. The number of holes on damaged plants apparently cannot be used as an index of larval population, although severity of damage might indicate different population levels.

The results of these experiments are not directly applicable to the field because the larva-plant ratio in the experiments probably exceeded that normally found in the field.

These data and subsequent field observations indicate that crops can survive the damage caused by first- and second-instar larvae. Consequently, this more nearly complete knowledge of the behaviour of the larva and of the nature of the damage has added materially to an evaluation of field populations based on an examination of plant damage.

The fact that first-instar larvae of the pale western cutworm feed below ground may limit the use of contact insecticides for control.

Summary

First-instar larvae of the pale western cutworm, *Agrotis orthogonia* Morr., feed below the ground surface. The external symptoms on the growing plant, in the form of notches and punctures, are the result of subterranean feeding and are made visible by elongation of the growing leaf.

Experiments show that an increase in larval numbers results in additional damaged plants. It appears impracticable to determine field larval populations from the number and extent of feeding holes on early growth of wheat.

References

1. Cook, W. C. Field studies of pale western cutworm (*Porosagrotis orthogonia* Morr.). *Montana Agr. Expt. Sta. Bull.* 225. 1933.
2. Seamans, H. L. The pale western cutworm and its control. *Canada Dept. Agr. Pub.* 615. 1938.
3. Webster, R. L., and C. N. Ainslie. Pale western cutworm in North Dakota. *North Dakota Agr. Coll. Bull.* 179. 1924.

The Canadian Species of *Epiptera* (Homoptera: Achilidae)[1]

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Fulgorids of the genus *Epiptera* Metcalf are well represented in the Canadian fauna, probably because they are associated with conifers. Metcalf (1938. *Gen. Cat. Hemip.* IV, Part 10) listed 12 North American species, of which seven had been recorded from Canada. Ten species are represented by specimens from Canada in the Canadian National Collection. Two of these are previously undescribed. As there has been much confusion among certain species of this genus, due partly to misinterpretations of some of the original descriptions, it is probable that previous Canadian records for some species were based on misidentifications. The species show external characters that are usually of good specific value, although there is some variation. The colour and type of markings of the face and the shape of the vertex are of particular value. The male genitalia exhibit good specific characters in the form and structure of the aedoeagus (Figs. 8-12).

I wish to thank Dr. P. W. Oman, of the Bureau of Entomology and Plant Quarantine, United States Department of Agriculture, Washington, D.C., for the loan of specimens for examination.

Key to Canadian Species of *Epiptera*

1. Upper half of frons dark brown or black, strongly contrasting with the white or pale-yellow lower half (Figs. 1-3) 2
   Frons brownish or yellowish, the upper half not sharply darker than the lower 7
2. Dorsal surface deep blackish-brown, almost uniform .... *opaca* (Say)
   Dorsal surface brownish, usually variegated with greyish or ochraceous 3
3. Clypeus black or dark blackish-brown (Fig. 1) 4
   Clypeus brown or yellowish-brown (Figs. 2, 3) 6
4. Larger species, over 9 mm. in length; western only 5
   Smaller species, 8-9 mm. in length; eastern .... *brittoni* Metc.
5. Vertex one and a half times as wide as long (Fig. 15) .... *fusiformis* (Van D.)
   Vertex about as long as wide (Fig. 16) .... *henshawi* (Van D.)
6. A narrow species in proportion to its length; length 7-8 mm., width 3 mm.; clypeus concolorous with lower half of frons (Fig. 2) .... *slossoni* (Van D.)
   Broader species; length 7-8.5 mm., width 4 mm.; clypeus obviously darker than lower half of frons (Fig. 3) .... *confusa* n. sp.
7. Clypeus distinctly darker than frons (Fig. 4) 8
   Clypeus not darker than frons (Figs. 5-7) 9
8. Vertex one and a half times as long as its basal width (Fig. 13); elytra almost uniform brown .... *floridae* (Walk.)
   Vertex barely as long as its basal width (Fig. 14); elytra variegated with greyish white .... *pallida* (Say)
9. Front brown, irrorated paler throughout (Fig. 5); vertex obviously wider than long (Fig. 17) .... *variegata* (Van D.)
   Front irrorated paler only at sides (Fig. 6) or not at all (Fig. 7); vertex as long as or longer than its basal width 10
10. Frons darker than clypeus, irrorated paler at sides (Fig. 6) .... *manitobiana* n. sp.
    Frons and clypeus unicolorous brownish (Fig. 7) .... *septentrionalis* (Prov.)

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Epiptera opaca (Say)

Flata opaca Say. 1830. J. Acad. Nat. Sci. Philadelphia 6: 239.
Helicoptera vestita Provancher. 1889. Pet. Faune Ent. Canada 3: 221.
Helicoptera pinorum Manee. 1910. Ent. News 21: 117.

This species is easily recognized by its almost uniform dark-brown colour. The only pale markings are a yellowish spot at the end of the claval area and one at each end of the stigma. Viewed microscopically, however, the elytra are seen to be minutely irrorated yellowish. Quebec: Norway Bay (G. E. Shewell); Ontario: Hastings Co. (Evans). It has been recorded previously from Ontario and British Columbia.

Epiptera fusiformis (Van Duzee)

Elidiptera fusiformis Van Duzee. 1910. Trans. Am. Ent. Soc. 36: 82.

This, like *henshawi*, is a large insect, averaging over 10 mm. in length. The two species are easily distinguished by the shape of the vertex (Figs. 15, 16). British Columbia: Agassiz (R. Glendenning), Departure Bay (G. E. Taylor), Cowichan Lake (J. M. Swaine), Seton Lake (J. McDunnough), Alberni.

Epiptera henshawi (Van Duzee)

Elidiptera henshawi Van Duzee. 1910. Trans. Am. Ent. Soc. 36: 83.

British Columbia: Brookmere (R. D. Bird), Midday Valley, Merritt (K. F. Auden, N. L. Cutler, and Mathers), Victoria (K. F. Auden). It has been recorded previously from British Columbia.

Epiptera manitobiana n. sp.

Vertex elongate, tapering, the lateral margins slightly arched, the anterior margin rounded; frons strongly carinate, the lateral margins elevated; clypeus carinate; pronotum obtusely produced between the eyes; mesonotal carinae present but weak. Length 9-10 mm.

Ground colour rich dark brown; vertex, pronotum, and mesonotum closely irrorated ochraceous, the vertex and the median area of the mesonotum sometimes largely ochraceous; frons (Fig. 6) rich dark brown, the lower half irrorated paler at the sides; clypeus brown; the gene, the narrow ventral margin of the breast plate, and the pro-pleuron and meso-pleuron ochraceous, breast plate otherwise dark brown, almost black; abdomen brown; legs light brown; elytra dark brown, closely and irregularly marked with greyish ochreous.

Aedoeagus (Fig. 8) with the lateral plates rounded, the median processes each broad at base, evenly tapering, and almost straight; the median ventral process long.

Holotype ♂.—Aweme, Manitoba, October 25, 1924 (N. Criddle). No. 5906 in the Canadian National Collection, Ottawa.

Allotype ♀.—Aweme, Manitoba, July 16, 1925 (N. Criddle).

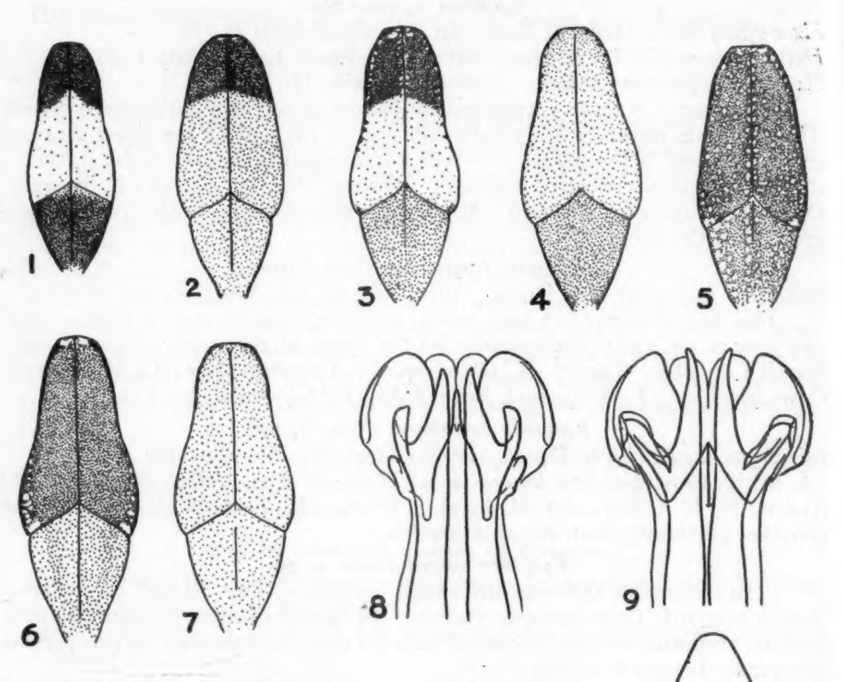
Paratypes.—1 ♂: Aweme, Manitoba, July 9, 1927 (N. Criddle); 3 ♀: Aweme, Manitoba, September 19, 1923 (N. Criddle), Aweme, Manitoba, July 31, 1925 (R. M. White), and Treesbank, Manitoba, August 3, 1928 (R. H. Handford).

This is a distinctive species in its large size, strong markings, and general deep greyish-brown colour. It is perhaps most closely related to *pallida* and *confusa*.

Epiptera slossoni (Van Duzee)

Helicoptera slossoni Van Duzee. 1908. Proc. Acad. Nat. Sci. Philadelphia 1907: 476.

This species is easily recognized by its narrow form, as well as by the coloration of the face (Fig. 2). Quebec: Mt. Lyall, at 1500 feet (W. J. Brown). This species has been recorded previously from localities across Canada, from the Maritimes to British Columbia (A. W. A. Brown. 1941. *Canada Dept. Agr. Tech. Bull.* 31: 16), but it seems possible that some or all of these records may refer



Figs. 1-17. *Epiptera* spp. 1-7, colour and markings of front of head of: 1, *E. brittoni* Metc.; 2, *E. slossoni* (Van D.); 3, *E. confusa* n. sp.; 4, *E. pallida* (Say); 5, *E. variegata* (Van D.); 6, *E. manitobiana* n. sp.; 7, *E. septentrionalis* (Prov.). 8-12, apex of aedoeagus, ventral view, of: 8, *E. manitobiana*; 9, *E. confusa*; 10, *E. variegata*; 11, *E. pallida*; 12, *E. septentrionalis*. 13-17, vertex, showing shape, of: 13, *E. floridae* (Walk.); 14, *E. pallida*; 15, *E. fusiformis* (Van D.); 16, *E. henshawi* (Van D.); 17. *E. variegata*.

to other species. Elsewhere, it has been recorded only from localities in New Hampshire and New York.

Epiptera variegata (Van Duzee)

Helicoptera variegata Van Duzee. 1908. Proc. Acad. Nat. Sci. Philadelphia 1907: 479.

This species is easily recognized by its very short vertex (Fig. 17) and irrorated face (Fig. 5). Superficially, it resembles *septentrionalis* or *pallida* but tends to be more strongly marked than those species. Quebec: Maniwaki and Ft. Coulonge (Forest Insect Survey); Ontario: Achroy and Dahlia (Forest Insect Survey), S. March (T. N. Freeman), Mer Bleue (W. J. Brown, L. J. Milne, and J. A. Adams).

Epiptera brittoni Metcalf

Epiptera brittoni Metcalf. 1923. J. Elisha Mitchell Soc. 38: 175.

In this species the clypeus is black, instead of brown as in *confusa* (see remarks under that species). I have not seen Canadian specimens of *brittoni*. It has been recorded from New Brunswick, Quebec, Ontario, Manitoba, Saskatchewan, and British Columbia by A. W. A. Brown (1941. loc. cit.). It seems possible that some or all of these records may refer to *confusa*.

Epiptera confusa n. sp.

Helicoptera pallida Van Duzee (nec Say), 1908. Proc. Acad. Nat. Sci. Philadelphia. 1907: 476-9.

Epiptera pallida Metcalf (nec Say). 1923. J. Elisha Mitchell Soc. 38: 159.

Epiptera pallida Van Duzee (nec Say). 1923. Connecticut Geol. Nat. Hist. Surv. Bull. 34: 129.

Epiptera pallida Dozier (nec Say). 1923. Mississippi Agr. Expt. Sta. Tech. Bull. 14: 43.

Vertex elongate, narrow, the lateral margins slightly arched and the anterior margin rounded; frons with the median carina strong and the lateral margins elevated; clypeus not or very weakly carinate; pronotum obtusely produced between the eyes; mesonotal carinae distinct. Length 7.8—9.0 mm.

Ground colour brown; vertex irregularly marked ochraceous, usually mainly ochraceous; pronotum and mesonotum closely irrorated ochraceous or ochraceous tawny; frons (Fig. 3) dark brown on upper half, pale yellow on lower half; clypeus tawny brown to brown; the pale-yellow band of the face continued across each gena, the ventral margin of the breast plate, and the pro-pleuron and meso-pleuron; breast plates otherwise black or blackish-brown; abdomen dark brown, the segments narrowly bordered paler; legs brown; elytron brown; irregularly marked and mottled greyish ochraceous, often becoming dark brown at apex of claval region and at apex of costa, with traces of an irregular, dark-brown, transverse band at ⅓, and with two or three dark-brown spots near apex.

Aedoeagus (Fig. 9) with the lateral plates bluntly pointed at their apices, the median processes long, relatively slender, and the median ventral process short, rapidly and evenly tapering.

Holotype ♂.—Cascapedia, Quebec, June 12, 1938 (W. J. Brown). No. 5905 in the Canadian National Collection, Ottawa.

Allotype ♀.—Covey Hill, Quebec, June 20, 1927 (G. S. Walley).

Paratypes.—4 ♂: Barraute, Quebec, July 4, 1938 (J. M. Caron), Cascapedia, Quebec, June 12, 1933 (W. J. Brown), Dauphin, Quebec (J. R. Dickson), and Blueberry Creek, British Columbia, June 23, 1939 (T. G. Laughton); 2 ♀: Fredericton, New Brunswick, June 19, 1929 (L. J. Simpson), and Covey Hill, Quebec, June 30, 1927 (G. S. Walley).

This species has often been confused with *pallida* (Say), but is easily distinguished from that species by the coloration of the face (Figs. 3, 4), as well as by the male genitalia (Figs. 9, 11). It differs from *brittoni* in the brown clypeus, generally lighter coloration, broader frons, and more sharply pointed vertex, and in the absence of a distinct clypeal carina.

Epiptera pallida (Say)

Flata pallida Say. 1830. J. Acad. Nat. Sci. Philadelphia 6: 240.

This species is likely to be confused with *septentrionalis*, which it closely resembles (see remarks under that species). Quebec: Cascapedia River (C. C. Smith); Labrador: Goose Bay (W. E. Beckel); Saskatchewan: Cypress Hills (A. R. Brooks), Waskesiu (Forest Insect Survey); Yukon: South Rampart House (D. H. Nelles).

Epiptera septentrionalis (Prov.)

Helicoptera septentrionalis Provancher. 1889. Pet. Faune Ent. Canada 3: 220.

This species resembles *pallida* in form and colour, but is on the average slightly larger. The two species are easily separated by the colour of the face (Figs. 4, 7), as well as by the male genitalia (Figs. 11, 12). Labrador: Muskrat Falls, Hamilton River (S. E. Arthur); New Brunswick: Harcourt (M.B.D.), Miscou Harbour (C. H. Young); Quebec: Gaspe Co. (R. Gobeil), Mt. Lyall at 1500 feet, Mt. Albert at 3000-3200 feet, and Cascapedia (W. J. Brown), Aylmer (J. N. Knull), Brule River Camp, Riordan Limits; Ontario: Sudbury; British Columbia: Lindup (E. W. Thomas).

Epiptera floridae (Walker)

Monopsis floridae Walker. 1851. List Homop. Insects 2: 326.

The long, pointed vertex and the almost unmarked brown elytra distinguish this species. The female described by Van Duzee (1910. *Trans. Am. Ent. Soc.* 36: 83) evidently is not of this species. The female is similar to the male in form and colour, differing only in size; the male is 7 mm. in length; the female, 9-10 mm. Ontario: Constance Bay (W. J. Brown).

Notes on a Collection of Dragonflies (*Odonata*) from Nova Scotia

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During the past four years Mr. Douglas C. Ferguson has collected dragonflies in Nova Scotia thereby greatly increasing our knowledge of the geographical distribution of these insects within the province. He very generously presented to the writer his entire collections compr'sing 327 specimens of 51 species, four of these being new records for the Maritime Provinces and two others being new for Nova Scotia. In the annotated list of species below these new records are indicated as follows: New records for the Maritime Provinces are indicated by a double asterisk (**). Records which are new for Nova Scotia only, are indicated by a single asterisk (*). A better representation of the widely distributed northern genus *Somatochlora* would have been expected in a collection of this size made from the territory covered, in view of the fact that at least eight species are known to occur in this territory. The reasons for their escaping capture is doubtless due, in part, to the restricted habitat occupied by many of the species, and in part to the difficulty of collecting specimens.

I am greatly indebted to Dr. Minter J. Westfall, Jr., of the University of Florida, Gainesville, Florida, for determining *Tetragoneuria canis* and for confirming my determinations of the six species on which the new records reported

herein are based. Most of all I am indebted to Mr. Ferguson whose diligent and discriminating field collecting made this note possible.

The present list together with all records previously published bring the total number of species known from the Maritime Provinces to 92; and for Nova Scotia individually, the number now stands at 82.

List of Species

1 *Agrion aequabile* (Say)
Glenville, August 13, 1949, 1 ♂ 1 ♀. Waverley, July 1, 1948, 2 ♀.

2 *Agrion maculatus* Beauvais
Pictou, July 19, 1944, 3 ♂ 2 ♀. Glenville, August 13, 1949, 2 ♂. Waverley, July 1, 1948, 1 ♂.

3 *Lestes congener* Hagen
Windsor Junction, October 10, 1948, 1 ♂.

4 *Lestes dryas* Kirby
Mt. Uniacke, July 8, 1949, 1 ♀; July 13, 1947, 6 ♂ 2 ♀. Hubbards, August 3, 1947, 2 ♂; August 4, 1947, 1 ♀.

5 *Lestes forcipatus* Rambur
Hubbards, August 3, 1947, 5 ♂ 4 ♀; August 4, 1947, 1 ♂ 1 ♀.

6 *Lestes rectangularis* Say
Mt. Uniacke, July 13, 1947, 2 ♂. Hubbards, August 3, 1947, 1 ♂.

7 *Lestes unguiculatus* Hagen
Parrsboro, July 31, 1948, 1 ♀. Hubbards, August 4, 1947, 1 ♂.

8 *Argia moesta putrida* (Hagen)
Washabuck, Bras d'Or Lakes, July 1, 1947, 2 ♂. Mt. Uniacke, August 4, 1947, 2 ♂; September 5, 1948, 1 ♂.

9 *Argia violacea* (Hagen)
Mt. Uniacke, August 4, 1947, 4 ♂. Waverley, June 21, 1947, 3 ♂.

10 *Chromagrion conditum* (Hagen)
Waverley, June 21, 1947, 1 ♂ 1 ♀. Armdale, June 14, 1948, 3 ♂.

11 *Nehalennia gracilis* Morse
Mt. Uniacke, August 4, 1947, 1 ♀.

12 *Nehalennia irene* Hagen
Waverley, August 21, 1949, 1 ♂. Armdale, August 11, 1948, 1 ♀.

13 *Enallagma boreale* Selys
Waverley, June 7, 1947, 2 ♀; June 20, 1947, 1 ♂; June 21, 1947, 1 ♀. Mt. Uniacke, May 22, 1949, 1 ♀; June 1, 1947, 3 ♂ 1 ♀; June 1, 1949, 2 ♀; June 13, 1947, 2 ♀. Armdale, June 14, 1948, 1 ♂.

14 *Enallagma carunculatum* Morse
Mt. Uniacke, July 8, 1949, 1 ♂.

15 *Enallagma civile* (Hagen)
Mt. Uniacke, July 20, 1948, 1 ♀. Armdale, August 4, 1947, 1 ♂. Hubbards, August 3, 1947, 2 ♂ 3 ♀.

16 *Enallagma cyathigerum* (Charpentier)
Waverley, June 21, 1947, 2 ♂. Mt. Uniacke, June 22, 1947, 1 ♂.

17 *Enallagma ebrium* (Hagen)
Mt. Uniacke, June 20, 1947, 1 ♂; June 23, 1947, 1 ♂. Waverley, June 21, 1947, 3 ♂ 1 ♀. Armdale, June 14, 1948, 1 ♂. Hubbards, August 3, 1947, 2 ♂; August 4, 1947, 1 ♂.

18 *Enallagma hageni* (Walsh)
Washabuck, Bras d'Or Lakes, July 1, 1947, 13 ♂ 11 ♀. Baddeck, July 3, 1947, 1 ♂ 1 ♀. Waverley, June 21, 1947, 6 ♂ 2 ♀; July 1, 1948, 3 ♂.

19 *Ischnura verticalis* (Say)
Washabuck, Bras d'Or Lakes, July 1, 1947, 5 ♂ 4 ♀. Hubbards, August 3, 1947, 1 ♂ 3 ♀. Waverley, June 21, 1947, 1 ♀. Mt. Uniacke, August 4, 1947, 1 ♂.

20 *Hagenius brevistylus* Selys
Hubbards, August 3, 1947, 1 ♀.

21 *Gomphus exilis* Selys
Mt. Uniacke, July 8, 1949, 1 ♂ 1 ♀; June 13, 1947, 3 ♂; June 20, 1947, 1 ♂ 1 ♀; June 23, 1947, 1 ♀. Waverley, June 21, 1947, 1 ♂ 1 ♀; July 1, 1949, 1 ♀.

**22 *Gomphus spicatus* Hagen
Mt. Uniacke, May 19, 1947, 1 ♂.
This is the first record for this species from the Maritime Provinces. It has previously been reported from Maine and was expected to occur here.

*23 *Gomphus (Gomphurus) ventricosus* Walsh
Mt. Uniacke, June 18, 1948, 1 ♀.
This species has been recorded from New Brunswick but was hitherto unknown from Nova Scotia. It is a very rare species in collections, and apparently seldom encountered in the field.

24 *Basiaeschna janata* (Say)
Mt. Uniacke, June 13, 1947, 1 ♀.

25 *Aeshna canadensis* Walker
Sackville, September 18, 1948, 1 ♂ 1 ♀. Waverley, August, 1948, 1 ♂.

26 *Aeshna clepsydra* Say
Waverley, August 27, 1948, 1 ♂.

27 *Aeshna interrupta interrupta* Walker
Sackville, September 18, 1948, 2 ♂.

28 *Aeshna umbrosa* Walker
Mt. Uniacke, June 23, 1947, 1 ♂. Waverley, August 27, 1948, 1 ♂ 1 ♀. Sackville, September 18, 1948, 1 ♂ 1 ♀.

29. *Cordulegaster diastatops* (Selys)
Pictou, August 1, 1947, 1 ♀.

30 *Cordulegaster maculatus* Selys
Centerville, July 23, 1948, 1 ♂.

31 *Didymops transversa* (Say)
Waverley, June 7, 1947, 2 ♂; June 21, 1947, 1 ♂ 2 ♀. Mt. Uniacke, June 13, 1947, 2 ♂; June 20, 1947, 1 ♂.

32 *Tetragoneuria canis* MacLachlan
Centerville, June 6, 1949, 2 ♂. Cape Breton I., Margaree Valley, July 6, 1949, 1 ♂ 1 ♀.

33 *Tetragoneuria spinigera* Selys
Waverley, June 7, 1947, 1 ♂.

34 *Helocordulia uhleri* (Selys)
Waverley, June 7, 1947, 1 ♂. Mt. Uniacke, June 13, 1947, 1 ♂.

35 *Somatochlora incurvata* Walker
Waverley, August 21, 1949, 1 ♀; August 22, 1948, 1 ♂. Armdale, September 6, 1949, 1 ♂.
The Maritime Provinces seem to be the centre of greatest abundance for this species which was formerly thought to be restricted to the Great Lakes region.

36 *Dorocordulia lepida* (Hagen)
Waverley, June 21, 1947, 1 ♀; July 1, 1948, 1 ♀.

37 *Cordulia shurtleffi* Scudder
Waverley, June 7, 1947, 1 ♂. Baddeck, August 7, 1948, 1 ♂.

**38 *Celithemis elisa* (Hagen)
Mt. Uniacke, July 20, 1948, 5 ♀; June 23, 1947, 7 ♂ 1 ♀.
These are the only records for this species from the Maritime Provinces, but judging from the number of specimens collected at Mt. Uniacke they would seem to be fairly common at this locality.

**39 *Celithemis martha* Williamson
Mt. Uniacke, July 20, 1948, 2 ♂.
This is another new record for the Maritime Provinces. It has not been previously reported north of Maine.

40 *Libellula* (*Ladona*) *exusta* Say
Waverley, June 7, 1947, 1 ♂ 2 ♀; June 21, 1947, 1 ♂ 1 ♀. Mt. Uniacke, June 20, 1947, 1 ♂ 1 ♀; July 13, 1947, 1 ♂; August 4, 1947, 1 ♀.

41 *Libellula* (*Ladona*) *julia* Uhler
Mt. Uniacke, June 1, 1947, 1 ♂ 3 ♀. Waverley, June 7, 1947, 1 ♂ 1 ♀. Baddeck, August 7, 1948, 4 ♂ 3 ♀.

**42 *Libellula* (*Holotania*) *luctuosa* Burmeister
Mt. Uniacke, July 11, 1946, 1 ♂.
The first known capture of this large and conspicuous species in the Maritime Provinces. It was not expected to occur there.

*43 *Libellula* (*Neotetrum*) *pulchella* Drury
Mt. Uniacke, July 28, 1946, 2 ♂; June 1, 1947, 1 ♂.
This species was known from New Brunswick, but has not been reported from Nova Scotia before.

44 *Libellula* (*Libellula*) *quadrimaculata* Linne
Armdale, May 31, 1947, 1 ♂. Waverley, June 7, 1947, 3 ♂; June 21, 1947, 2 ♂ 3 ♀. Washabuck, July 1, 1947, 2 ♂. Mt. Uniacke, June 13, 1947, 1 ♂; June 18, 1948, 2 ♂.

*45 *Libellula* (*Plathemis*) *lydia* Drury
Hubbards, August 3, 1947, 1 ♂.
Another species previously recorded from New Brunswick but hitherto unreported from Nova Scotia.

46 *Sympetrum costiferum* (Hagen)
Pictou, August 1, 1947, 1 ♀. Hubbard, August 3, 1947, 3 ♂ 2 ♀. Wolfville, August 19, 1948, 2 ♂. Mt. Uniacke, September 5, 1948, 3 ♂.

47 *Sympetrum internum* Montgomery
Parrsboro, July 31, 1948, 1 ♀. Pictou, August 1, 1947, 1 ♀. Baddeck, August 7, 1948, 1 ♂ 3 ♀. Halifax, August 22, 1942, 2 ♂ 1 ♀. Hubbards, August 3, 1947, 5 ♂. Wolfville, August 19, 1948, 2 ♂. Waverley, August 27, 1948, 7 ♂ 1 ♀; September 16, 1948, 1 ♀. Armdale, July 26, 1942, 1 ♀; August 1, 1943, 1 ♀; September 6, 1949, 1 ♂. Mt. Uniacke, September 5, 1948, 1 ♂. Sackville, September 18, 1949, 1 ♂ 1 ♀.

48 *Sympetrum semicinctum* (Say)
Sackville, September 18, 1949, 3 ♂ 1 ♀.

49 *Sympetrum vicinum* (Hagen)
Waverley, August 21, 1949, 3 ♂ 1 ♀; August 27, 1948, 2 ♀. Armdale, August 11, 1948, 1 ♂; September 16, 1948, 2 ♂ 2 ♀. Sackville, September 19, 1949, 1 ♂ 2 ♀.

50 *Leucorrhinia hudsonica* (Selys)
Mt. Uniacke, May 17, 1949, 1 ♂; June 1, 1947, 2 ♂; June 13, 1947, 1 ♀. Waverley, June 7, 1947, 1 ♀. Baddeck, July 3, 1947, 1 ♀. Purcell's Cove, July 6, 1947, 1 ♀.

51 *Leucorrhinia intacta* Hagen
Centerville, June 4, 1949, 1 ♂; June 6, 1949, 5 ♂. Waverley, July 1, 1948, 1 ♀. Baddeck, June 29, 1949, 1 ♂; August 7, 1948, 1 ♂ 1 ♀.

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Ants Attacking Larvae of the Forest Tent Caterpillar, *Malacosoma disstria* Hbn. (Lepidoptera: Lasiocampidae)

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During field studies of the behaviour of larvae in colonies of *Malacosoma disstria* Hbn., it was observed that two species of ants[1], *Camponotus herculeanus ligniperdus* (Latr.) and *Formica fusca* L., were common on the twigs of the small trees, *Populus tremuloides* Michx., on which the caterpillars were established. Ant nests were common near the bases of trees, and the worker ants climbed the trunks and moved along the branches either to forage or to tend aphid colonies. When the tent caterpillars were small, they were frequently attacked by the ants. There were two distinct types of attack: one the result of foraging by worker ants and the other the result of defence of aphid colonies by the ants.

Foraging ants were chiefly *Camponotus* workers. When an ant moving on a tree encountered a colony of *Malacosoma* larvae in any stage of development from the first to the fourth instar, it immediately grasped a caterpillar and carried it off to the nest. Successive trips were made to the colony of larvae until all individuals were removed, the process taking no more than one day. Removal of single larvae in this manner did not appear to disturb the remainder of the colony. In 1949, these attacks were so persistent that 12 colonies, or a total of some 1,800 larvae, were removed; and it was necessary to band the trees to keep ants away until larvae in the remaining colonies reached the fifth instar, when they

[1]The species of ants were determined by G. S. Walley, Systematic Entomology, Division of Entomology, Department of Agriculture, Ottawa, Canada.

were large enough to be left undisturbed by the ants. During the spring of 1950, which was a much wetter season, predation did not occur to such a marked extent.

The second type of attack, namely, that by defenders of aphid colonies, occurred both in 1949 and in 1950 when young larvae were moving about the trees to feed or to moult. During such movements, the larvae sometimes moved through an aphid colony tended by ants of either species. On such occasions the ants immediately attacked the larvae. The type of attack varied with the number of ants tending the aphids.

If one or two ants were with the aphids, they would attack and kill the larvae, frequently tearing them to pieces in the process. Dead larvae were left lying on the twig or were dropped from it. On the other hand, if more than two ants were with the aphids, they would kill the larvae and carry them to the nest, always leaving at least one ant with the aphids. Either type of behaviour was effective in destroying whole colonies of the forest tent caterpillar in either of the first two instars. Older caterpillars seemed to be able to protect themselves to some extent from attacks by defenders of aphid colonies. Although the ants succeeded in driving the large larvae away from the colonies, they seldom succeeded in killing them.

A Note on the Dusting of Crops with Fluorescein to Mark Visiting Bees[1]

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Last year a short note (Musgrave, 1949) described the possibilities of fluorescein for marking insects. The method has since been adopted and much elaborated by the Apiculture Department here (Townsend, 1950).

But another and very interesting question remained insufficiently answered: was it possible to dust a growing crop with fluorescein (and presumably, certain other solids) in such a way that visiting bees alighting on the crop would pick up the dust and carry it back to the hive on their bodies in detectable quantities? If it were then a very useful tool in field research in Entomology generally might well be available. During the summer of 1950 an experiment was devised to answer this question.

The materials used in this experiment were purchased samples of talc and fluorescein-sodium salt (a technical grade). The method used to detect any such material on bees was to kill the insects in a cyanide bottle and then transfer them to a vial of 0.15% potassium hydroxide in water, and observe the result with the unaided eye.

The experiment was done on a small scale on a local building lot where sweet clover, blue weed, burdock, gladioli and vegetables were growing. A beehive was sited on this lot. An area of weed growth (largely blue weed) was paced out, 9 paces by 10. This area was distant about 100 yards from the hive. It was being well worked by hive and wild bees. In the early afternoon of 21 August, 1950 this area was dusted with a mixture of 1 lb. talc and ½ lb. fluorescein. Several hours later (when no hive bees were working) a bumble bee captured from the area showed clear evidence of contamination. Forty-eight hours later, after dew and very light rain, it was found that honey bees captured from the treated area were distinctly contaminated with fluorescein. Bees

[1]Part of the program of the Legume Research Committee in Ontario.

collected at the hive were, however, unmarked. This was probably because insufficient bees were collected, for it was obvious that only a very small proportion of the total population of the hive was working the small area treated.

On 23 August, 1950 a second application of 1½ lbs. of the mixture was made to the same area and to an adjacent area of about the same size. A few hours later the hive was visited, the experimenter wearing fresh clothes and using a different net and killing bottle. Ten collections (of varying numbers) of bees were made. Each collection was examined separately. In the first collection one bee showed clear evidence of fluorescein contamination: the material could be seen dissolving from the insect. The following day similar collections were made, and a marked bee was found in the third collection: the fluorescein appeared to have been mixed with the pollen.

It is felt that these findings justify the conclusion that visiting bees (and presumably other insects) will pick up fluorescein from a dusted crop and carry it some distance; and that a crop dusted in this way remains effective for at least 24 hours. It may be remarked that the unmarked bees that were collected form an adequate check in the experiment.

Fluorescein clings well to both bees and plants and is moderately persistent. It seems likely that the method would work with much smaller quantities of material.

The method might provide an excellent means of determining the origin of captured insects.

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A Note on Collembola

During the summer of 1949 a number of Collembola were collected from soil and litter samples. These samples were taken in a preliminary study on the ecology of timber types on the Kananaskis Forest Experiment Station, near Seebe, Alberta. A Berlese funnel was used to remove the insects from the debris. The springtails were sent to H. G. James, Dominion Parasite Laboratory, Belleville, Ontario, for determination.

In the group taken from the top two inches of soil and litter collected beneath trembling aspen on June 10, 1949, the following species were represented: ***Entomobrya*** sp. nr. ***marginata*** (Tullb.), ***Achorutes armatus*** var. ***cuspidatus*** Axelson, and ***Isotoma*** sp. In soil and litter collected beneath lodgepole pine on September 23, 1949, the species present were: ***Folsomia quadrioculata*** (Tullb.), ***Entomobrya*** sp. nr. ***marginata*** (Tullb.), ***Onychiurus subtenuis*** Fols., ***Achorutes armatus*** var. ***cuspidatus*** Axelson, and ***Isotoma*** sp.

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Forest Insect Laboratory
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